ENERGY CONSERVATION REFERENCE and MANAGEMENT GUIDE for CHURCHES

Energy Office
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INTRODUCTION

First compiled in 1996 by Jerry Nash, and updated in 2002 by Scott DeVries, this manual is produced as an energy conservation reference and management guide for religious buildings (churches). It is an attempt to bring together, in a usable format, some of the wealth of practical suggestions and experience to be found in the energy field.

The manual consists of six sections, each addressing a different aspect of a total energy conservation program. This is a manual and not a book to be read from cover to cover. Each section contains practical information and suggested procedures and forms designed to be used in implementing a specific part of an energy conservation program.

The sample forms included in this manual are designed to be removed, copied, and used to implement and monitor energy conservation in your church. The forms can be used as they presently appear or easily modified to meet the specific needs of a church.

Further information regarding energy use in Michigan churches, and advice on saving energy in those and other buildings can be obtained from the State of Michigan, Energy Office; an agency within the Department of Consumer & Industry Services.

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SECTION I.
CONSERVATION GUIDELINES

This section includes recommended policy guidelines in the areas of:

1. Heating/Cooling Temperatures
2. Domestic Hot Water Temperatures
3. Lighting Levels

The levels recommended here have been found to provide an acceptable environment while decreasing energy consumption. These or similar guidelines should be included in a church's energy conservation policy and procedures. This assures a clear understanding of the church's commitment to energy conservation and provides everyone involved with objective criteria by which to measure and enforce conservation. For example, a clear policy on temperature levels notifies members and staff of expected building temperatures and tends to increase accountability and decrease controversy.

Recommended Heating Level		**Recommended Cooling Level**	
Occupied	Unoccupied	Occupied	Unoccupied
68-70°	55°*	78°	off

***Caution: Be sure to maintain a temperature level that will prevent pipes from freezing.**

Recommended Domestic Hot Water Temperatures

Use	Occupied	Unoccupied
Personal	105°	Off
Kitchen	Maintain Health Department requirements. For information, contact Michigan Dept. of Community Health, (517) 373-3740	Off

Lighting Levels

The chart below presents recommended lighting levels in foot-candles. Foot-candles (fc) should be measured at the task or work level.

Area	Standard
Nave	10-30 fc
Classrooms	30-50 fc
Offices	30-50 fc
Store Rooms	10 fc
Toilets/Washrooms	10-20 fc
Corridors/Stairways	10-20 fc

SECTION II.
ENERGY DATA

Energy data serves a needs assessment and evaluation function, as well as providing warning signals of mechanical or operational failures. Accurate, comprehensive data on energy consumption helps a church do the following:

1. Set preliminary and continuing benchmarks for an energy program;
2. Set priorities for action;
3. Evaluate the program's success.

The amount of energy used in any one building is dependent on many factors, such as: type of construction; heating, ventilation, and air conditioning (HVAC) system design; building orientation; and external environmental conditions; as well as a building's operating procedure's impact on its energy consumption level. It is possible, however, to set some general "targets" for church energy consumption levels.

National Average Consumption per Square Foot per Year

Fuel Oil	Natural Gas	Electricity	Total
.22 Gal. or 30,900 Btu	.28 Ccf or 28,840 Btu	3.4 kWh or 11,604 Btu	37,400 Btu

(Mostly from U.S.D.O.E., Energy Information Administration, CBECS)

The targets should be used as a yardstick for judging the potential for energy savings and as initial goals in an energy conservation program. For example, if a church building is consuming 50 percent more energy than the target, the potential for substantial savings is high. It could reasonably be expected that implementation of a good energy conservation program would yield high dividends in energy savings. Note that experience has shown that natural gas use in Michigan churches tends to be considerably higher than the national average, most likely due to Michigan's colder than average climate. It is not unusual for natural gas use to be twice as high in Michigan.
Actual Michigan only based averages are not available at this time.

Expressing energy in Btu allows comparisons of total energy used between churches. The Btu is a non-metric measure of energy used by engineers. All forms of energy can be converted to Btu and thus comparative efficiencies can be examined.

Conversions to Btu

Energy Form	Btu Equivalent
100 cubic feet (ccf) natural gas	103,000
1 Gal. #2 fuel oil	138,690
1 Gal. #6 fuel oil	149,690
1,000 lbs. steam	1,390,000
1 standard short ton coal	24,500,000
1 kWh electricity	3,413

In order to compare your church with the "target" energy usage, you need to (1) obtain 12 months of energy data, (2) convert your electricity and natural gas (or fuel oil) usage to Btu, and (3) calculate your Btu/square foot/year figure for your church. Your 12 months of energy data can be obtained either from your own records, if you have kept copies of your utility bills, or by asking your utility for the most recent 12 months data. Most utilities will provide this data at no cost to their customers. The following chart indicates how to convert one kWh of electricity, one ccf of natural gas (Note: some utilities bill in 1,000 cf, or Mcf), and one gallon of #2 fuel oil to Btu.

Electricity:

$$\frac{\text{Annual kWh} \times 3413}{\text{Square Footage}} = \text{Btu/sq. ft./year}$$

Natural Gas:

$$\frac{\text{ccf of nat. gas} \times 103{,}000}{\text{Square Footage}} = \text{Btu/sq. ft./year}$$

#2 Fuel Oil:

$$\frac{\text{Gallon of \#2 oil} \times 138{,}690}{\text{Square Footage}} = \text{Btu/sq. ft./year}$$

Once your Btu/square foot/year statistics have been calculated for your church, you should compare your energy usage to the targets to see how your church is doing. Is your electricity higher than average? How does your natural gas or fuel oil usage compare to the target? An ongoing log like the following should be maintained so that you can monitor your progress in reducing your energy usage.

Btu/Square Foot/Year

	Electricity	Natural Gas	Heating Degree Days*	Total
Targets	11,604	28,840		37,400
2000	10,000	34,000	6,155	44,000
2001	9,500	37,000	6,728	46,500
% Change	-5.0	+8.8	+9.3	+5.7
2002				
% Change				
2003				
% Change				
2004				
% Change				

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*Heating degree days for several cities in Michigan can be obtained from http://www.cpc.ncep.noaa.gov/products/analysis_monitoring/cdus/degree_days/DD_index.html. If you don't have internet access call the State of Michigan Energy Engineer at (517) 241-6154. Use the cumulative heating degree days in the tables for June to represent the heating degree days for the previous winter. Heating degree days provide a measure of how cold a heating season has been. The more heating degree days, the colder the winter. Without heating degree day data it would be difficult to understand whether your natural gas usage has gone down because of your energy conservation program or because of colder weather. In the example above, the harsher winter in 2001 explains why the natural gas usage has increased.

Once energy consumption data is generated, it is imperative that the information be distributed to all the people that need it. Decision makers need the information if they are to understand and participate in the energy conservation program. Energy information should be shared with the custodian, the pastor, the church council, the properties committee, and others. With good data, a church can show its members that the conservation efforts are saving energy and reducing costs.

SECTION III.

ENERGY AWARENESS CHECKLIST

The following is a checklist of energy conservation techniques that should be implemented by all churches concerned with saving energy and energy dollars. The list is not intended to be exhaustive, but does include many suggestions to save energy.

Lighting

1. Reduce lighting to recommended levels.

2. Reduce incandescent light wattage or replace with fluorescent lights or compact fluorescent lamps.

3. Evaluate decorative and display case lighting.

4. Reset outside light timers periodically to minimize use.

5. Use brightly colored light switch stickers to remind people to turn out the lights when leaving rooms.

6. Install occupancy sensors on lights that are often left on when the room is unoccupied, such as restrooms and storage areas.

7. Require custodians to use lights only in rooms being cleaned. Schedule daylight cleaning where possible.

8. Use multiple switching to allow selection of various light levels. New dimmable ballasts are also available for fluorescent lights.

9. Label multiple switches to indicate which lights they operate.

10. Replace fluorescent lamps on a regular basis, i.e., after 80 percent of their lamp life is used. (Fluorescent lamps use more energy and produce less light during the last 20 percent of life.) – This is most useful in areas where there are many lamps that get the same amount of use.

11. Disconnect ballasts from fixtures that have the bulbs removed -- they use a small amount of energy and will burn up if not disconnected.

12. Keep light fixtures clean and replace yellowed lenses.

Winter Season: Heating and Ventilation

1. Set thermostats at recommended levels, 68-70° for winter or at temperatures set by administrative or board guidelines.

2. Reduce temperatures in restrooms and vestibules. Experiment, but avoid freezing water lines.

3. Maintain storage rooms and unoccupied spaces at 50-55°, but prevent freezing of water lines.

4. Set night setback temperature at least 10° below daytime temperature.

5. Activate night setback control cycle as early in the day as possible. Try one hour before room usage ends.

6. Check and set all time clocks for minimum equipment operating times.

7. Upgrade inoperative control systems. If pneumatic, make sure there are no line leaks.

8. Consider shutting down heating plant during unoccupied hours and during mild weather.

9. Reduce fresh air to minimum on ventilation fans (2-5 CFM per person).

10. Check that fresh air intake dampers on ventilation fans are closed at night, when the building is on the warm-up cycle, and when fans are off.

11. Experiment with starting ventilation fans later and shutting them off earlier.

12. Experiment with shutting off exhaust fans and check that backdraft dampers close tightly.

13. Locate wall hangings, displays, and furniture away from supply and return air grilles and registers to prevent obstruction of airflow.

14. Use windows for ventilation in mild weather and shut off ventilation fans.

15. Establish a maintenance program for the heating, ventilation, and air conditioning system to include:

    a. Repair or replacement of leaking steam traps and control valves.
    b. Repair leaks in heating piping.
    c. Repair or replacement of heating system piping insulation.
    d. Cleaning boiler combustion chamber.
    e. Cleaning scale from waterside of boiler surfaces.
    f. Cleaning boiler room combustion air intake.
    g. Cleaning and/or replacement of air filters in unit vents and air handling systems.

h. Cleaning fin tube radiation.
i. Cleaning air grilles and registers.
j. Repair leaking ductwork, especially check flexible connections to air handlers.

16. Establish operating and maintenance plans for the central boiler, chiller, and distribution systems.

Summer Season: Cooling/Ventilation

1. Operate air conditioning units only when absolutely necessary.

2. Set cooling thermostat setting at 78° F. or at established guidelines.

3. Do not cool spaces that are not occupied.

4. Use outside air for cooling on cool days instead of operating the air conditioning system.

5. On cool nights, operate fan systems or economizers periodically at 100 percent outside air to cool non-air-conditioned buildings.

6. Install ambient air temperature controls on air conditioning system to lock out compressor operation when outside air temperature drops below a predetermined temperature.

7. Turn off non-critical exhaust fans.

8. Reduce internal heat gain as much as possible by turning out lights and shutting off equipment.

9. Seal leaks in ductwork.

10. Insulate all chilled water lines, refrigerant suction lines, and cold air ducts.

Domestic Water Systems

1. Set water temperatures at recommended levels. See Section 1 of this manual.

2. Shut off water-using equipment when not in use.

3. Install a time clock to control domestic hot water pumps.

4. Adjust flush valves for minimum use.

5. Consider automatic shut-off water taps.

6. Use cold water for the first rinse of dishes.

7. Use the dishwasher only when it is filled.

Miscellaneous

1. Caulk around all door and window frames.

2. Weather-strip all doors and windows.

3. Consider sealing gravity vents in storage rooms.

4. Cover window air conditioners and caulk around them in winter.

5. Use vestibule doors if they are in place.

6. Check that door closures are working properly.

7. Keep desks away from outside walls as much as possible.

8. Keep condensers clean on air conditioning units, drinking fountains, refrigerators, freezers, coolers, etc.

9. Check door gaskets on refrigerators and freezers.

10. Use light colored reflective paint when repainting.

11. Consider installing twist timers or occupancy sensors on exhaust fans with manual switches.

12. Use EnergyStar equipment and set up EnergyStar power down capabilities on computers, printers, etc. where available. Check http://www.energystar.gov/products to see which products are available with the EnergyStar label.

13. Turn off equipment not in productive use (i.e., cold rooms, refrigerators, freezers, ovens).

14. Encourage staff and members to utilize blinds and curtains. Closed blinds and curtains on south and west exposures will help keep a building cool in summer, while opening them will help warm the building.

15. Develop a detailed shutdown program for maximizing energy savings during unoccupied time.

16. Hold exterior doors open only during passage of occupants entering and leaving the building. Limit the number of entrances used during arrival and departure hours. Keep door closures in good repair; remove hold-open devices.

17. Where feasible, eliminate use of north and west entries in cold weather. If north and west entries must be used, provide an exterior windbreak to eliminate the wind tunnel effect.

SECTION IV.
HVAC CONTROLS

This section addresses the need for energy conservation in the heating, ventilation, and air conditioning (HVAC) system. The major components of the HVAC system are the heart of a building's operations. As long as there is adequate heat on cold days or cooling on hot days, very few complaints are heard. However, if the building is too cold in winter or too hot in summer, you know the reaction! In most cases, the comfort level is adequate, but many dollars and Btu are being wasted by inefficient furnaces, boilers, excessive exhausting of conditioned air, or a large intake of outside air that has to be heated or cooled.

Lack of training and HVAC expertise is a major concern when conserving energy. The properties committee members and custodial staff do their best to provide a good environment, but are often not trained to perform the job that is expected of them. Just as open-heart surgery is performed by a surgeon rather than a general practitioner, an efficient HVAC system must be supervised and maintained by a person trained and qualified in that area.

The following guidelines and procedures should be put into practice by an outside contractor or your professional staff and/or volunteers who have expertise in maintaining or calibrating the equipment. Be sure to specify to the service personnel what is expected of them and the results you want to achieve.

Furnaces/Boilers

The furnace or boiler is the front end of the heating system. It is critical that these units be maintained both from an efficiency and a safety aspect. Be sure that any person making repairs or adjustments to the furnace or boiler is qualified. Furnaces/boilers can be very dangerous if an individual is unfamiliar with them. Don't be afraid of a furnace or boiler, but respect them!

Burner Efficiency:

Burner efficiency relates to the manner in which a furnace and/or boiler receives, mixes, and properly burns fuel to produce heat. When converting a fuel to heat, there is always a certain amount of loss that cannot be avoided. The goal of tuning a boiler burner is to minimize the amount of heat lost to the atmosphere. You will save approximately 2 percent of your consumption for

every 1 percent you improve your burner efficiency. It is recommended that a flue gas test be done at least annually.

Boiler Heat Transfer:

Boiler heat transfer is the method by which the heat produced by the burner is transferred to the media and circulated to a building's heating units to provide a comfortable environment. To provide effective heat transfer, insulators such as soot and scale in the boiler and system must be held to a minimum. Proper water treatment and general internal boiler maintenance are required to achieve this goal. Only 1/32-inch of soot will cause an average fuel loss of 2.9 percent. Cleaning the boiler should be done annually.

Boiler Controls:

Boiler controls are the means by which a boiler is operated. Many times we find that habit rather than expertise are the operational standards -- "that's the way we have always done it." This can lead to excessive and wasteful use of fuels. Set the correct guidelines for boiler operation and control, and in-service your boiler operators, if necessary.

Boiler Safety:

Obviously, the church must maintain a safe environment, and to that end, boiler safety has a direct relationship with energy conservation. Many of the items to be checked regularly for safety will also alert staff to potential inefficiency problems with the burner or heat transfer. Documentation of inspections, maintenance, major service, etc. is a very important factor if a problem is incurred. Therefore, a log sheet should be maintained which shows when routine maintenance, malfunction repairs, etc. are done.

Main Heating Loop:

The main heating loop is the portion of the system that supplies and returns the heating media to and from the heating units. Controlling the supply temperature in this system will provide a comfort zone and minimize the overheating or under heating of a building. Maintaining this portion of the total system is very important, especially when steam is the heating source. Steam systems use steam traps, which are subject to failure and can cause major inefficiencies to occur in

the heating system. Traps should be checked on a regular basis and failed traps should always be replaced immediately.

Pneumatic and Electronic Controls:

Most churches are equipped with either pneumatic or electronic temperature control systems. These systems provide a means of signaling equipment, sensors, relays, etc. of what they should or should not do. If any of the controls are out of calibration or synchronization on front-end or downstream equipment, the system or units cannot operate in an efficient or effective manner.

A. Air compressor operation and maintenance

1. Keep the tank drained of condensate regularly, depending on moisture build-up.
2. Keep drive belts properly adjusted.
3. Keep the intake air filter clean.

B. Pneumatic controls

1. Inspect regularly for air leaks, oil seepage, water in controls, loose linkage, damaged or broken components, etc.
2. Functional-check the controller to assure that it is operable.

C. Electronic controls

1. Clean all electronic controls regularly, inspect and tighten all electrical connections.

D. Day/night setback system

1. Locate and label all night thermostats.
2. 55° is the recommended setting for night thermostats.
3. Program the time clock to correspond to occupied hours with a minimal warm-up cycle and a maximum cool-down cycle.
4. If day cycle is needed for evening activities or custodians, use a system with a manual override to produce an intermittent warm-up cycle (approximately two hours).
5. Timer overrides can also be used for after-hours control of heating or cooling systems.
6. Inspect time clocks on a regular schedule to assure proper calibration of clock, day cycle, night cycle, and weekend cycle.

Air Conditioning

Air conditioning is approximately three times more expensive to operate than heating. It is very necessary to operate and maintain your systems at maximum efficiency for adequate cooling and still conserve energy. Most people would prefer to have temperatures of 75° in winter, but prefer 68-70° in summer. Why? How about short sleeves in the summer and sweaters in the winter, and reverse those temperature settings!

1. Thermostats should be set to cool a space no lower than 75° for day and 85° for night.
2. Areas that have minimal or no occupancy should not be cooled.
3. Filters should be cleaned or replaced regularly to assure maximum operating efficiency.
4. Window air conditioners should be covered in winter to prevent air infiltration.

Exhaust Fans

Exhaust fans are a source of large heat losses from a building. Fans are needed in some cases to remove odors, fumes, moisture, or excessive heat from a particular area. They are in place to be used if needed. Thousands of dollars of conditioned air are exhausted needlessly, due to lack of control.

1. Evaluate the need for all exhaust fans and eliminate or reduce their operational hours whenever possible.
2. Inspect all exhaust fans for proper operation of back draft dampers to reduce air infiltration and heat loss.
3. Provide for effective exhaust fan control by installing twist timers, clock timers, keyed switches, occupancy sensors, etc.
4. Keep motors, fan blades, and air grilles free of dirt to reduce energy usage and extend useful life.
5. Exhaust fans should be off during unoccupied hours.
6. For proper control, all exhaust fans should be identified as to area served and on/off control points and then labeled. This information should also be drawn on a building schematic and posted for custodial and maintenance staff.

SECTION V.
OPERATIONS AND MAINTENANCE AUDIT

Energy management is a step-by-step process. A successful program begins with the most obvious conservation steps and, among the most obvious; those that are lowest in cost should come first. This section describes the role of the operations and maintenance (O&M) audit in identifying specific items or areas within a building where energy is being wasted and describes how an O&M audit can be used to set up a prioritized list of corrections to be made.

The O&M audit is a structured review of all the energy-related aspects of a building. The goal of the audit is to determine ways to provide for minimal operational time while maintaining a comfortable environment. In addition, the audit should identify the maintenance procedures for saving energy and minimizing major repair problems. The O&M audit includes three distinct aspects:

1. Collection of basic information about the building(s) in order to provide a database for recommended actions. This basic information should include building size, operating procedures and schedules, structural integrity, and equipment design and condition.

2. A listing and assessment of operation changes or maintenance actions that might improve the building's energy efficiency. Identified changes should be prioritized based on payback and difficulty of implementation.

3. A brief assessment of the need for energy conservation measures requiring extensive capital outlays.

Preparing for the O&M Audit

Where to Begin:

Which buildings or areas should be audited first? The church's developing database should show which buildings or areas use the most energy per square foot, and therefore offer the potential for greatest savings. Another method to use to identify buildings or areas for energy audits is the horsepower of the motors driving the ventilating fans. The more "fan horsepower" in a building, the more likely the building can benefit from the results of an audit. The newest buildings or areas of a building are also prime targets for consideration because they contain high energy HVAC systems. It is axiomatic that the more complex the controls, the less likely that the system is operating properly. One should always assume automatic controls are working below design standards, thus

causing energy waste.

Establishing the Audit Team:

The audit team should include the pastor, head custodian, a member of the properties committee, and any volunteers. At least one member of the team should have a working knowledge of the building's HVAC systems. The role of the audit team is to inspect and analyze the church's energy systems and to support changes, especially those that can be implemented quickly and at little or no cost -- the "Quick Fix."

The team will need the appropriate tools: a light meter, thermometer, flashlights, the small-scale building plan, a cassette recorder, and note-pads.

Conducting the O&M Audit

At the beginning of the audit the team should spend a few minutes discussing the building in general using the small-scale building plan for an overall review of the building. If it is the first audit for most team members, their role -- to question how and why the building's energy systems are operating and make suggestions for possible changes -- should be discussed. The team should be made familiar with the operating practices of the building. This is also a good time to discuss the building's utilization schedule.

The team should be reminded that the audit is a building survey to generate the maximum level of observation and the greatest number of conservation suggestions possible. The team should be asked to concentrate on modifications in maintenance, operations, and scheduling -- whatever can be implemented quickly and at little or no cost (again, the Quick Fix; a review of the Energy Awareness Checklist found in Section III of this manual could help update team members on Quick Fix techniques).

As the team begins the tour, four specific energy-saving categories should be highlighted: light level reduction, ventilation reduction, unoccupied shutdown, and temperature setback. The team should be asked to keep the following questions in mind as they survey:

1. Occupancy Schedule
   Can night and weekend uses be consolidated on one night, or into a single wing, or moved into another building?
2. Lighting Levels
   Do they conform to guidelines? Can lamps be removed, circuits added, or more

efficient lamps substituted?

3. Thermostat Settings
   Do they conform to guidelines? Can they be lowered in winter, raised in summer? (Careful attention to thermostats can result in substantial reduction in energy consumption.)

4. Ventilation
   Has the amount of outside air been reduced to a minimum? Are there automatic controls to shut off ventilation if a space is unoccupied?

5. Unoccupied Shutdown
   Are there automatic controls to turn off unit ventilators and other fan units when the space is unoccupied? If so, are these working and set for a minimum number of operating hours?

6. Temperature Setback
   Are there automatic controls to change to a night thermostat setting of 50-55°F or 85°F during the appropriate season whenever the building or area is unoccupied?

The O&M Audit Report

When the audit tour is completed, one person must prepare the report. The audit report becomes the basic energy conservation document for each building. The audit report should be complete and detailed and should include the completed O&M checklist and the team's recommendations for action. While the O&M audit should emphasize low-cost or no-cost changes, only minor attention in the report need be given to the amount of energy saved by a particular change. (Most of the items identified by the checklist will save enough energy to quickly offset the minor labor costs involved in implementing them.) Comments and suggestions can be grouped by major category, such as HVAC, building construction, O&M, lighting, and miscellaneous. Each category should list or summarize the audit team's findings and any suggestions. The most important part of the report is a list of operational and/or maintenance changes to be implemented. One way of organizing such a list is shown on the following pages as a sample form, "The Audit Write-Up," or you may choose to use the more detailed "Operations and Maintenance Audit" forms beginning on page 22 of this manual.

The Audit Write-Up

_____ _____

Building Date of Audit

1. Brief description of the building's HVAC system:
   A. Is there an operations manual/warranty? Who installed the system? Any blue prints/plans/emergency procedures, etc. available?

_____
_____
_____

2. Brief description of the building structure:

_____
_____
_____

3. Brief description of utilities:

_____
_____
_____

4. Observations and recommendations:
   A. Heating and ventilating system (ventilation reduction, temperature setback, unoccupied shutdown) -

_____
_____
_____

   B. Lighting -

_____
_____
_____

   C. Heat loss and infiltration -

_____
_____
_____

   D. Furnaces, boilers, and air conditioning units -

_____
_____
_____

E. Domestic hot water -

_____
_____
_____

F. Other -

_____
_____
_____

Recommended operational and maintenance changes:

1._____
_____
2._____
_____
3._____
_____
4._____
_____
5._____
_____

Implementing O&M Audit Recommendations

Copies of the completed report should be distributed to each team member and to the properties committee. The actual implementation of the recommendations varies with the organization of the church. If, for instance, the properties committee is responsible for corrective action, the committee may issue work orders for the quick-fix items. In many cases, recommendations can be implemented without a work order. For example, a custodian or church volunteer familiar with building systems needs only an activities schedule to begin timely shutdowns and setbacks. This same individual can also make minor systems adjustments.

With the initial O&M audit complete and the changes implemented, the properties committee is now responsible for seeing that all measures continue to be carried out. The reward for this vigilance is the satisfaction of monitoring falling energy consumption in the building. But the process does not end here -- continued progress requires follow-up audits to identify the need for renewed or additional energy conservation measures.

SAMPLE FORM

Operations and Maintenance Audit

This checklist is to be used on the walk-through of each building and/or area. It is intended to identify the condition and mode of operation of the church.

Church Address _____
_____
_____

Building Area _____ Sq.Ft._____

Audit Person(s) _____ Date of Audit _____
_____

1. Energy Consumption:

Fiscal Year	Natural Gas (ft^3)	Oil (gals)	Electricity (kWh)	Water/Sewer(gals)
20__				
20__				
20__				

Btu/Ft^2/Yr: Heating _____ _____ _____

2. Maintenance:

   a. Who maintains equipment? _____
   b. Who reads meters? _____ Frequency _____
   c. Has reading been compared with utility bills? Yes _____ No_____
   4. What do custodians maintain? _____

3. Comments:

_____
_____
_____
_____

STRUCTURAL

1. Building Envelope (Exterior):

   a. General Condition - Good_____ Fair_____ Poor_____

   b. Structural cracks - Yes_____ No_____

   c. Expansion joint condition - Good_____ Fair_____ Poor_____

   d. Comments - _____

ROOF

1. Condition: Good_____ Fair_____ Poor_____
2. Leaks: Yes_____ No_____
3. Pitch pockets: Yes_____ No_____
4. Skylights: How many_____ Insulated: Yes_____ No_____
5. Blisters: Yes_____ No_____
6. Expansion joints: Yes_____ No_____
7. Roof drains: Clean_____ Dirty_____ Functional_____
8. Flashings: Condition: Good_____ Fair_____ Poor_____
9. Bare felts: Yes_____ No_____
11. Debris on roof: Yes_____ No_____
12. Comments:

_____
_____
_____
_____

EXTERIOR DOORS

1.	Type:	a. Wood	Good_____	Fair_____	Poor_____	
		b. Steel	Good_____	Fair_____	Poor_____	
		c. Aluminum	Good_____	Fair_____	Poor_____	
		d. Other	Good_____	Fair_____	Poor_____	
2.	Vestibule doors:		Yes_____ No_____	Are they used?	Yes_____	No____
3.	Closure operation:		Good_____	Fair_____	Poor_____	
4.	Weather-stripping:		Good_____	Fair_____	Poor_____	None____
5.	Threshold condition:		Good_____	Fair_____	Poor_____	
			Needs replacement_____			

WINDOWS

1. Glass: Single_____ Double_____ Triple _____ Storms: Yes_____ No_____
2. Frame: Wood_____ Steel_____ Aluminum_____ Other_____
3. Frame condition: Good_____ Fair_____ Poor_____
4. Window type: Fixed_____ Awning_____ Double hung_____ Other_____
5. Window fit: Tight_____ Loose_____ Needs adjustment_____
6. Weather-stripping: Good_____ Fair_____ Poor_____ None_____
7. Glazing: Good_____ Fair_____ Poor_____
8. Caulking: Good_____ Fair_____ Poor_____
9. Shading: Awnings_____ Blinds_____ Shades_____ Screens_____
   Curtains_____ Drapes_____ Other_____
10. Comments:

_____
_____
_____

LIGHTING - INTERIOR

1. Lighting type -- No. of lights:

   Fluorescent_____ Incandescent_____ Mercury vapor_____

   Metal Halide_____ High pressure sodium_____ Low pressure sodium_____

2. Type of controls: Manual_____ Time clock_____ Central control _____

3. Security lights: Yes_____ No_____

4. Shut-off Reminder stickers: Yes_____ No_____

5. Light cleaning schedule: Yes_____ No_____ How often?_____

6. Lamp removal: Yes_____ No_____ Lamps burned out? Yes_____ No_____

7. General light levels: High_____ Low_____ Adequate_____

8. Note areas with high and/or low light levels:

_____
_____
_____

LIGHTING - EXTERIOR

1. Lighting type -- No. of lights:

   Fluorescent_____ Incandescent_____ Mercury vapor_____

   Metal Halide_____ High pressure sodium_____ Low pressure sodium_____

2. Type of controls: Manual_____ Time clock_____ Photocell_____

   Functional: Yes_____ No_____

3. Hours of operation: _____
   _____

KITCHEN

1. Dishwasher: Yes_____ No_____

   a. Hot water temperature to washer: _____

   b. Temperature after booster: _____

   c. Type of booster: Electric_____ Natural gas-fired_____

   d. Booster heater control: Interlock w/master_____ Manual_____ Other_____

   e. Hours of operation:_____

Comments:

_____
_____
_____

2. Preheating

   a. Oven: Yes_____ No_____ How long?_____

   b. Grill: Yes_____ No_____ How long?_____

   c. Kettles: Yes_____ No_____ How long?_____

Comments:

_____
_____
_____

3. Refrigerators:

   Yes_____ No_____ Number_____

   a. Temperature: _____

   b. Door gasket condition: Good_____ Fair_____ Poor_____

   c. Efficient use: Yes_____ No_____ Percent full_____

   d. Condenser type: Air cooled_____ Water cooled_____

   Clean_____ Dirty_____

   Water regulating valve leaking? Yes_____ No_____

Comments:

_____

_____

_____

DOMESTIC HOT WATER

Yes_____ No_____

Heater No.	Location	- Type -			Water Temp.	Type of Control		Circulation Pump		Pump Control		
		Gas	Oil	Electric		Aquastat	Time Clock	Yes	No	Manual	Time Clock	Return Temp.

1. Pipe insulation: Good___ Fair_____ Poor_____ None_____

2. Leaks: Yes_____ No_____

3. Shower control: Yes_____ No_____

   a. Reduced flow heads: Yes_____ No_____

   b. Shut-off valves: Manual_____ Automatic_____

   c. Leaks: Yes_____ No_____

Comments:

_____

_____

_____

EXHAUST FANS

Yes_____ No_____

	Type of Control					No. of Fans	Tight	Shutoffs	Hours of Oper.	Date of Oper.	Dirty	
Type	Manual	Light Switch	Time Clock	Twist Timer	Central Control		Yes	No			Yes	No
Toilets												
Kitchen												
Dish Washer												
General												
Other												

Comments:

_____

_____

_____

AIR CONDITIONING UNITS

Yes_____ No_____ Number_____

Type	Condenser		Type of Control				Discharge Air Temp.	Area Served	Winterized	
									Yes	No

Comments:

_____

_____

_____

BOILER AND PIPE INSULATION

Good_____ Fair_____ Poor_____ None_____

1. Steam traps: Yes_____ No_____

2. Trap rebuild program: Yes_____ No_____ How often rebuilt?_____

3. Steam to hot water converter:

   a. Heating: Yes_____ No_____ Functional: Yes_____ No_____

   b. Domestic: Yes_____ No_____ Functional: Yes_____ No_____

Comments:

_____

_____

_____

PNEUMATIC CONTROL SYSTEM

1. Air compressor: Yes_____ No_____

   a. Pressure settings: On_____psi Off_____psi

   b. Minutes on/off: _____/_____

   c. Drain valve: Yes_____ No_____ Manual_____ Automatic_____

   d. Air intake: Inside_____ Outside_____ Clean_____ Dirty_____

   e. Summer operation: Yes_____ No_____

   f. Maintenance level: Good_____ Fair_____ Poor_____

   g. Air leaks: Yes_____ No_____

   h. Drive Belt adjusted properly: Yes_____ No_____

2. Night setback system: Yes_____ No_____ Functional: Yes_____ No_____

   a. Degree setting: Night_____ Day_____

   b. Are clocks at correct time setting? Yes_____ No_____

3. Room/area thermostats:

   a. Are they calibrated? Yes_____ No_____ How often?_____

   b. Temperature setting: _____

   c. Are they locked? Yes_____ No_____

Comments:

_____
_____
_____

HEATING SYSTEM

1. Hot water heating pumps: Yes_____ No_____

No. of Pumps	Location	Type of Control			Functional		Hours of Operation
		Manual	Zone thermostat	Outside air temp.	Yes	No	

Comments:

_____
_____
_____

Inventory - Service Record Worksheet

Date_____

Church_____ Building_____

Area	I.D.	Fuel type	Fuel usage	Service Require.	Frequency	Last Serviced	Comment

SECTION VI.
PREVENTIVE MAINTENANCE PROGRAM

Preventive maintenance (PM) is an organized and planned program to keep all components of the equipment in peak operating condition. Wear and tear on buildings and equipment inevitably leads to changes in operating efficiency. A PM program assures that continuous and periodic measures are taken to minimize deterioration of the building and equipment and maintain maximum operating efficiency.

PM requires a fair investment in the beginning. If a church board or council accepts and agrees to these investments, a PM program can be established which would save money for the church in the following four ways:

1. PM can extend equipment life by periodic inspection, lubrication, and adjustment.
2. PM can identify small problems before they become major problems and reduce equipment downtime.
3. PM can help avoid costly emergency repairs.
4. PM can ensure safe, quiet, and efficient operation of equipment.

The value of a good PM program is twofold. Traditionally, preventive maintenance has been viewed as a way of extending equipment life and reducing costly emergency breakdowns. It will do that. But, a good PM program can also help reduce energy consumption. Properly adjusted and maintained equipment will operate much more efficiently than equipment receiving little or no maintenance. And more efficient equipment operation means reduced energy consumption. This section explores how a successful PM program can be designed and implemented.

Designing the PM Components

The following five basic issues should always be remembered in designing and implementing a successful PM component.

Planning the System:

The maintenance, custodial, properties committee, and administrative staff should all be involved in designing the PM program. This will help ensure acceptance of the program, which is important since these people must all be involved for successful implementation.

Setting Priorities:

The PM program should establish priorities for maintenance. Critical and high energy-consuming equipment should be put on the PM system first. Other equipment can be added later.

Analyzing Existing Maintenance:

Before setting up its goals, a committee should begin looking at a PM design that will make the most efficient use of existing procedures and employee skills. The committee should analyze its current maintenance in the following six ways:

1. Review the level and frequency of maintenance currently being performed
2. Identify the areas of high maintenance
3. Identify person(s) currently maintaining the equipment
4. Determine whether or not present staff or volunteers can be trained to perform more maintenance.
5. Decide whether or not the existing work order system can be used for PM or if a new system should be designed.
6. Consider whether or not the PM program should be manual or computerized.

Organizing the Staff:

The properties committee and/or maintenance staff should be organized into two divisions -- one responsible for repairs and the other for PM. Unless such a division is created, repairs will take priority and preventive maintenance will not be performed regularly. Regardless of how large or small the staff, certain individuals should be assigned preventive maintenance as their primary responsibility.

Simplifying the Paperwork:

The PM program designed should be simple to operate and involve a minimum of paperwork. Whether or not the PM program is computerized, it must be "user friendly."

Implementing the PM Program

Once the goals are set, the current maintenance procedures have been analyzed, and a PM program has been designed, a church's PM program is ready for implementation and should involve the following six basic steps.

1. Inventorying equipment and building components
2. Establishing basic maintenance tasks
3. Prioritizing tasks and identifying manpower skills
4. Scheduling PM tasks
5. Developing a work order system
6. Monitoring PM performance

1. Inventorying Equipment and Building Components

High energy-consuming and critical mechanical and electrical equipment should receive top priority as an inventory is started. Less critical equipment can be inventoried later, after PM is successfully underway. An easy way to do a PM inventory is to use a tape recorder and tour the building(s) recording verbal comments on each piece of equipment. Then the data can be transferred to the inventory form when and where convenient. Your inventory form should be designed to answer the following questions for each piece of equipment included in the PM program: What is it? Where is it? How many are there?

2. Establishing Basic Maintenance Tasks

Different equipment requires different kinds of maintenance. However, there are six basic tasks or checks that are required to maintain most pieces of equipment:

a. Visual check -
PM person(s) should visually check major equipment daily to spot obvious problems.

b. Cleaning -
Scheduled cleaning of mechanical equipment is an important part of a PM program. PM person(s) should check for oil, dirt, and rust. Dirty equipment leads to increased breakdown and can mask critical problems.

c. Functional check -
PM person(s) should routinely inspect equipment for proper and efficient operation. A suggested list of functional checks has been developed for each major equipment type. Functional checks are a top priority and the heart of a PM program. They are usually performed by skilled maintenance staff.

d. Lubrication -
PM person(s) should keep the moving parts greased and oiled on a regular basis.

e. Service -
Some pieces of equipment require regularly scheduled adjustments. Such a service schedule should be incorporated into the PM program.

f. Vibration check -
PM person(s) should routinely inspect and record vibration levels, using a vibration meter.

On the following page is an example of the PM procedures included in the categories above. The sample form, "Preventive Maintenance Procedures," details the strategy for maintaining pumps. Similar forms can be developed for boilers, air compressors, fans, thermostats, and non-mechanical equipment (plumbing, doors, etc.).

Preventive Maintenance Procedures

- Pumps -

1. Visual Check (Custodial)
   Brief, daily inspection to include:
   a. Check for changes in noise, vibration, overheating of pump or motor.
   b. Check for leaks.
   c. Each week manually rotate pumps shut down for the season.

2. Clean (Custodial)
   Keep equipment clean; keep free of oil, dirt, mineral deposits, rust, etc. as necessary.

3. Functional Check (Skilled maintenance)
   a. Check oil level.
   b. Start pump if not running (in season only).
   c. Check for unusual noise, vibration, overheating.
   d. Check for leaks.
   e. Check gauge readings (pressure, temperature).
   f. Check for correct rotation.
   g. Check water level controls.
   h. Check alternator for proper operation.
   I. Check coupling and align if needed.
   j. Check seals and replace if needed.
   k. Check packing and repack if needed.
   l. Replace rubber motor mounts if needed.
   m. Check and clean strainers.
   n. Replace leaking check valves.
   o. Check sump pump pit for sludge and flush.
   p. Tighten loose bolts and connections.

4. Lubricate (Skilled maintenance)
   a. Change oil and clean oil reservoir on pumps with drain plug.
   b. Add oil to wick-lubricated pumps and replace wick if needed.
   c. Grease pumps and motors with grease fittings.
   d. Oil motors with oil cups.
   e. Clean, wipe down pump and motor.

5. Vibration Check (Skilled maintenance)
   Using a vibration meter, take readings and record.

3. Prioritizing Tasks and Identifying Manpower Skills

Priorities:

The PM program should establish priorities for maintenance tasks. Critical and high energy-consuming equipment should be the highest PM priority, with other less critical equipment receiving lower PM priority. Functional checks on critical equipment should have the highest priority since neglect of these checks could lead to major breakdowns which might affect keeping the church open or cause large repair bills.

Manpower Skills:

The properties committee chairperson or an appointee should decide at what skill level each staff member/volunteer is capable of performing. This decision determines who should do what. Skill Level 3 is the highest skill level, as detailed below.

Skill Level 3 - Usually does functional check, lube, service and vibration check of major equipment.

Skill Level 2 - Depending on abilities, usually does visual check, functional check, lube, and service of less complex equipment.

Skill Level 1 - Usually does cleaning tasks; may do functional check and lube of less complex equipment.

Matching Priorities and Skills:

At this point in the PM program, equipment maintenance procedures and personnel skill levels need to be matched, taking into account the unique capabilities of each staff member/volunteer. In some cases, a custodian may be very competent and can be assigned some high priority tasks. This is a very critical step and should be the responsibility of the properties committee chairperson or his/her appointee. The key is to know your people.

4. Scheduling PM Tasks

When inventory has been completed and the PM procedures and appropriate persons and skill levels have been identified, it is time to begin scheduling PM tasks. On page 45 is a sample form entitled "Preventive Maintenance Worksheet Schedule," that is designed to be used with major equipment types corresponding to the "Inventory Service Record Worksheet" (p.33) and "Check List for Mechanical Contractor's Furnace/Boiler" forms (p.46). For example, all the hot water heating

pumps in a building should be listed on a single Inventory Service Record Worksheet, and the frequency and timing of the various tasks and checks should be indicated. (Information on the suggested frequency and timing for PM on major equipment types can be provided from the equipment manufacturer, or the installer). Also, keep in mind that forms and procedures can be modified to meet your church's specific needs.

5. Developing a Work Order System

PM work orders should be generated from the master Inventory Service Record Worksheet on a monthly basis by the properties committee chairperson or appointee. A copy of the work orders(s) should be distributed to the proper maintenance person or volunteer and a copy kept on file. When the PM task is finished, the completed work order should be returned and the office copy removed from the file. If this procedure is done on a regular basis, a quick review of the office work order copies will show which PM tasks have been completed and which ones are still outstanding.

This PM work order system is simple to operate and effective in terms of managing and monitoring performance of the PM tasks and in determining costs thereof. Combined with a properly motivated person, the PM work order system can improve efficiency and substantially reduce expensive emergencies from equipment breakdowns.

Most churches may already have an existing work order system, but, if not, the following PM Work Order sample form along with the guidelines above could be easily implemented into your system.

Preventive Maintenance Work Order

Building Name	Date Due	Level	Name					Date Completed
Equipment Name/No.	Location	Clean	Functional Check	Lube	Service	Vibration Check	Other	Hours

6. Monitoring PM Performance

Once the PM program is designed, developed and implemented, it should be evaluated and reviewed for performance and modifications. The properties committee chairperson or his/her appointee should prepare a basic monthly report for each building. From this data the responsible person can determine which project or measure can demonstrate cost benefits of preventive maintenance.

Inspection List for PM

The properties committee is a most important group when it comes to keeping a church building operating well. Some committee members are sometimes there every day and often know more about the things that go on in a given building than anyone else. At least one of the members should go into the boiler room frequently in order to spot any changes that might mean trouble. (If a car doesn't sound "normal" one morning, the owner checks it out! The same should be done with the motors, fans, and pumps in the church building(s).)

On the following pages is a suggested listing entitled "PM Inspection List" that can be used to help make sure that the important places in the church building(s) are checked on a regular basis. If the details suggested on this list are monitored as needed, the building(s) will function better and equipment will last longer.

PM Inspection List

DAILY

One of the most important things you can do is LOOK, LISTEN, SMELL, AND FEEL your building every day. Your senses can tell you if something is "not right" and give you clues about trouble areas. The following areas should be checked often.

1. Observe stack vapor when approaching building.

2. Inspect the furnace:
    a. Filters
    b. Belt adjustments
    c. Burner flame
    d. Make up air intake
    e. Humidifier (if attached)

3. Inspect the boiler by:
    a. Checking the water level in the sight glass
    b. Checking the steam pressure/water temperature
    c. Looking at the burner flame and combustion dampers
    d. Checking the operation of the hot water heating pumps
    e. Draining the water from the air compressor tank and filter element drain bowl
    f. Scanning valves, piping, tanks and traps for leaks

4. Tour all mechanical rooms and visually check equipment (pumps, fans, air compressors, water heaters).

5. Observe kitchen and food storage rooms, cooler, freezer temperatures, oven pilots, and exhaust fans.

6. Check known problem areas.

7. Check all windows for damage.

WEEKLY

1. Equipment rooms, tunnels, attics:
    a. Inspect all pipes, hangers, valves, and traps.
    b. Fill floor drains with water and check for operation.
    c. Inspect fans, ductwork, dampers, air filters, and coils.

2. Classrooms and corridors:
    a. Check temperatures and thermostats. Examine doors, windows, and lights for condition and operation.

3. Roof (weather permitting):
    a. Check for debris and remove it.
    b. Check and clean all drains.
    c. Examine roof surface and report any problem areas and/or leaks.
    d. Check rooftop equipment for unusual noise, vibration, or overheating.
    e. Notice what equipment is running and if it needs to be on.

    Note: Special CAUTION should be taken while on the roof -- it is easy to damage the surface. Remember to:
    a. Walk on walkways when possible.
    b. Don't step on blisters, ridges, expansion joints, weak spots.
    c. Don't drop anything on the roof; you might puncture it.

MONTHLY

Check air-cooled refrigeration units for dirty condensers and clean if needed.

THREE TIMES A YEAR

Schedule time to clean the condensers in window air conditioners, refrigerators, freezers, coolers, and serving-line refrigeration units.

ANNUALLY

All finned radiation tubes should be cleaned once a year.

Preventative Maintenance Worksheet Schedule

Church_____ Building/Area_____

Type of equipment_____

_____

Serial No._____ Model No._____

--Maintenance Frequency--

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Type A tune-up*												
Type B tune-up*												
Type C tune-up*												
Clean and/or check:												
Belt(s)												
Oil motor(s)												
Register(s)												
Vent pipe(s)												
Condenser coil												
Evaporator coil												
Humidifier												
Filter												
Other												
Other												

*See checklist for mechanical contractor's furnace/boiler form for additional information.

Comments:

_____

_____

_____

Check List for Mechanical Contractor's Furnace/Boiler

Church_____ Building/Area_____

Type of equipment_____

_____

Model No._____ Type of tune-up/review*_____
(Type A, B, or C)

Contractor to record results and mark appropriate answer:	**Satisfactory****		
	Yes	**No**	**NA**
1. Check for any leaks (i.e., fuel, water, steam, exhaust).	___	___	___
2. Conduct leak test of heat exchanger, or disassemble and inspect.	___	___	___
3. Carbon monoxide test of ambient air; note results.	___	___	___
4. Carbon monoxide test of flue gasses; note results.	___	___	___
5. Net stack temperature (Pre___°F) (Post___°F).	___	___	___
6. O_2 or CO_2 reading (Pre___%) (Post___%).	___	___	___
7. Efficiency should be within 5% of Manufacturer's AFUE, or Steady State (SSE Pre___%) (SSE Post___%).	___	___	___
8. Actual input (Pre___kBtu) (Post___kBtu).	___	___	___
9. Draft test over flame (Pre___) (Post___); Draft test at breach (Pre___) (Post___).	___	___	___
10. Backdrafting?	___	___	___
11. Check vent system.	___	___	___
12. Check power supply.	___	___	___
13. Adequate fuel supply to control valve?	___	___	___
14. Adjust burner and gas input.	___	___	___
15. Adjust the pilot light and/or adjust combustible blower (for power blower).	___	___	___
16. Lubricate fans, motors, and pumps.	___	___	___
17. Check, adjust and/or replace belts, if worn.	___	___	___
18. Check and adjust thermostat/heat anticipator.	___	___	___
19. Check blower and high limit controls.	___	___	___
20. Check pressure regulator.	___	___	___

continued . . .

_____

* Type A tune-up (more than 75% of the items in this list reviewed);
Type B tune-up (more than 50%);
Type C tune-up (more than 25%).

**If "No" (not satisfactory), document findings and do follow-up(s) as necessary.

	Yes	No	NA
21. Adjust burner air shutters.	___	___	___
22. Check temperature rise (within range on rating).	___	___	___
23. The following areas should be clean:			
Squirrel cage -	___	___	___
Combustion chamber -	___	___	___
Cabinet -	___	___	___
Heat exchanger -	___	___	___
Burner ports and fire tubes -	___	___	___
Blower housing and motor -	___	___	___
Oil filters -	___	___	___
Return air filter -	___	___	___
24. Floor/wall fire protection.	___	___	___
25. Condition of tiles/glass.	___	___	___
26. Duct work (heat runs/return mix).	___	___	___
27. Proper Btu input.	___	___	___
28. Wiring condition.	___	___	___
29. Oil pump pressure set at 100 psi, or per manufacturer's recommendation.	___	___	___
30. Orifice replaced, if necessary.	___	___	___
31. Venting (chimney) system replaced or repaired.	___	___	___
32. Ensure proper draft.	___	___	___
33. Properly operating limit controls/auto fuel safety shut-off.	___	___	___
34. Turbulators (boilers).	___	___	___
35. Combustion air opening (clean or dirty).	___	___	___
36. Stack temperature.	___	___	___
37. Steam pressure (boiler) on/off.	___	___	___
38. Water temperature (boiler) on/off.	___	___	___
39. Water treatment (boiler).	___	___	___
40. Low water cut-off test (boiler).	___	___	___
41. Safety relief valve test (boiler).	___	___	___
42. Boiler controls functional.	___	___	___
43. Outside air temp. reset functional (boiler).	___	___	___
44. Outside air shut-off functional (boiler).	___	___	___
45. Three-way valve functional (boiler).	___	___	___
46. After tune-up, furnace/boiler should be performing within 5% of manufacturer's listing.	___	___	___

Comments:

_____

_____

_____